That architects are not entirely indifferent to this subject is shown by the fact that on the formation of the Department of Scientific and Industrial Research several years ago, the Royal Institute of British Architects formally directed attention to the need for acoustic experiments, associated with design and construction.

This need is recognised elsewhere, as is evidenced by the work done in America where, at Geneva, Illinois, in the laboratory of acoustics built for the late Prof. Sabine by Col. Fabyan, much valuable research has been carried out. Before his death in 1919 at the age of fifty, Prof. Sabine had collected a great deal of experimental data on sound in relation to materials, and his researches had sufficiently impressed themselves on American architects more than twenty years ago to result in consultations on acoustic design. The laboratory is now under the direction of Prof. Paul E. Sabine, some of whose recent researches are referred to elsewhere in this issue with a brief description of his laboratory. In this building, devoted solely to acoustic problems, the difficulties of adequate sound transmission and suppression are constantly being investigated. Work of this nature must eventually prove a valuable national asset by preventing wasted effort and expenditure, and the example of America is worth serious consideration in this country.

There are a great many problems in which the work of the man of science can materially assist the architect, not only in acoustics but also in the use of materials for construction generally, but if science is to have its due appreciation it must supply information of a practical and simple kind which will appeal to workers in a field already so wide that they have little time for the study of theory, however interesting.

The Body Temperature of Birds.

A Study of the Body Temperature of Birds. By Alexander Wetmore. Smithsonian Miscellaneous Collections, Vol. 72, Number 12. (Washington, D.C., U.S.A. : Smithsonian Institution.)

WITH regard to body temperature, animals are divided into two great groups, namely, warm-blooded and cold-blooded, the former including mammals and birds; the latter reptiles, amphibians, fishes, and all invertebrates. A more accurate distinction than the actual temperature, however, is based on the fact that the so-called warm-blooded animals have a constant temperature (homoiothermal) while the cold-blooded animals have a variable temperature which is practically the same as that of the environment in which they live (poikilothermal).

The essential difference between these two groups is, that homoiothermal animals—mammals and birds—possess a heat-regulating mechanism by means of which the heat production and heat loss are so balanced that the body temperature remains practically constant, while poikilothermal animals — all others, except mammals and birds—possess no such mechanism.

Although much time and research have been devoted by a host of investigators to the study of body temperature and heat production in mammals, comparatively little attention has been given to this field in avian physiology, and all interested in this much-neglected subject will be greatly indebted to the author of the above monograph for his important and valuable contribution.

The investigation covered a period extending from January 1912 to October 1919, and records were obtained from 1558 individuals of 327 species of birds distributed among 50 families. It was carried on within the limits of the United States of America, and all the year round, in temperate regions where the extreme cold of winter is not encountered. In addition to the 327 species examined by the author personally, the previously published records from 89 others are given in the form of a supplementary table, so that definite statements may be found in the work regarding the body temperature of 416 species of birds. A table giving the individual records in detail, not included because of the high cost of printing, is deposited in the files of the Smithsonian Institution of Washington, and may be consulted by those interested.

Specially constructed thermometers of the clinical type but with a wider range—95° F.+ to 115° F.+—were used. When a bird was shot a temperature reading was taken from the large intestine reached through the anus or from the proventriculus through the mouth, only when the specimen could be secured immediately. If there was any delay in retrieving a correct reading could not be made, so that it was only possible to secure records from less than half the birds collected. In the short time that intervened between the shooting and introduction of the thermometer, it is assumed that no appreciable loss of heat from the body took place, and that the figure recorded indicates the temperature immediately before death.

With regard to the diurnal rhythm of body temperature found in all homoiothermal animals, including man, the author was able to corroborate the work of previous observers, and it is particularly interesting to note that in nocturnal birds, such as owls, the normal rhythm is reversed, the temperature being highest during the night (period of activity) and lowest during the day (period of rest).

Hilden and Stenback found that by imposing an artificial night (period of darkness) and day (period of artificial illumination) on birds confined in a darkened room the temperature rhythm was altered. After the second day the diurnal birds adapted themselves to the changed conditions so that the maximum temperature occurred at night and the minimum during the day. When the experiment was ended and birds again led a normal life in relation to daylight, the diurnal rhythm quickly returned. A similar change of rhythm has been produced artificially in the monkey. This bears on the question as to the cause of the diurnal temperature rhythm in animals. Some believe that there exists in the body a fixed periodicity of which the temperature rhythm is an expression, and that this periodicity persists under all conditions, and is, to a large extent, independent of outside influences. Others are inclined to question the existence of this mysterious periodicity, and look upon the diurnal variation as being due entirely to the action on the body of the various outside influences which affect body temperature, notably, muscular activity and sleep. The fact that the rhythm may be altered by changing the daily routine appears to give support to the latter view.

Although a distinct diurnal body temperature rhythm is found in birds with a wider range in many cases than in mammals, there is little evidence of a seasonal variation. This is all the more interesting, since no class of non-hibernating homoiothermal animals show greater evidence of cyclical bodily changes than do birds. During moulting time, in the late summer and autumn, they shed their feathers and show other signs of depressed vitality, while in the spring, in preparation for the mating and breeding seasons, they put on fresh plumage and become extremely active. However, heat production, if not greatly increased in a short time, has no relation to body temperature.

As in the case of mammals, the temperature of the female was found to be slightly higher than that of the male of the same species and under the same conditions, in most cases, but in certain groups the opposite was found. For example, in the herons (Ardeidæ), in three species we have the following averages: Great blue heron (*Ardea herodias*), male, 104°·8 F., female, 103°·7 F. snowy heron (*Egretta candidissima*), male, 104°·8 F., female, 104°·0 F.; and the black-crowned night heron (*Nycticorax nævius*), male, 103°·5 F., female, 102°·6 F. Here there is a very pronounced difference in favour of the male, and the same is found in certain other shore birds.

Among other factors that influence the body temperature of birds it was observed that large masses of food, if cold, will frequently cause a sudden fall in temperature in a bird of small size, while bathing may produce a slight fall.

As in the case of mammals, nestlings and immature birds show a lower temperature and a wider variation than adults, due to the fact that the temperature control is less perfect. In a black-necked stilt (*Himantopus mexicanus*), one day old, a temperature as low as 95°·3 F. was recorded. Apparently this applies only to species with altricial offspring; it is not found in birds with precocial young, where the mechanism of temperature control is well organised at birth.

In considering the method of temperature control in birds, Mr. Wetmore believes, with Soum, that the air-spaces play an important rôle in the regulation of heat loss. On account of the feather covering and the absence of cutaneous glands, little heat is lost by radiation and evaporation from the skin. This throws an increased burden on the respiratory system, supplemented by the ostial spaces, and the regulation of heat loss through this channel is the chief factor in avian temperature control. The author brings forward some first-hand evidence in favour of this belief.

Discussing the significance of temperature control in general, the statement is made that "In the bird, the regulation of body temperature has reached its highest point, though birds stand second to mammals from an evolutionary point of view. Proof of this is found in the fact that birds have the highest body temperatures known, and that none of them hibernate." This conclusion scarcely seems justifiable on the evidence at hand. The degree of heat control of any species is not to be measured by the actual height of the body temperature, but rather by its diurnal variation, and according to this standard the regulation of body temperature appears to have reached its highest point in *Homo sapiens,* since the diurnal range in him is less than in any other so-called homoiothermal animal so far investigated, although the actual body temperature is among the lowest for mammals and far below that of any of the birds.

It is generally held that the higher the bird in the zoological scale, the greater is the body temperature. The author agrees with this statement, as a rule, but points out many discrepancies. If the appended tables be examined it will be noticed that, when arranged by families, the highest temperatures are found in pigeons, cuckoos, woodpeckers, and in the great passerine order beginning with the Tyrannidæ and ending with the Turdidæ. In five species of the former the average body temperature for male or female was 110° F. or more. The highest average temperature for both sexes was found in the western pewee (*Myiochanes richardsoni*) with a mean of 110°·2 F., the greatest single individual reading being 112°·7 F. Contrary to popular belief, it was found that the swallows, as a group, possess the lowest average body temperature. In seven species examined in this family one alone, the rough-winged swallow (*Stelgidopteryx serripennis*), showed an average greater than 107°·5 F. Humming birds also, "with their tiny bodies seem to have a considerable range in temperature, but as a whole fall low in body warmth."

The volume is an important monograph, containing much valuable data, and it is a noteworthy contribution to this field of avian physiology.

SUTHERLAND SIMPSON.

Prof. Eddington's Romanes Lecture.

Pour comprendre Einstein. Par l'Abbé Th. Moreux. Pp. 245. (Paris: G. Doin, 1922.) 7 francs.

Die Grundlagen der einstein'schen Relativitätstheorie: Eine kritische Untersuchung. Von Prof. Dr. H. Strasser. Pp. 110. (Bern: Paul Haupt, 1922.) n.p.

Philosophy and the New Physics: An Essay on the Relativity Theory and the Theory of Quanta. By Prof. Louis Rougier. Authorised translation from the author's corrected text of "La Matérialisation de l'énergie," by Prof. Morton Masius. Pp. xv + 159. (London: G. Routledge and Sons, Ltd., n.d.) 6*s.* net.

Le Principe de la relativité et les théories d'Einstein. Par Prof. L.-G. du Pasquier. Pp. xvi + 511. (Paris: G. Doin, 1922.) 18 francs net.

Le Principe de la relativité et la théorie d'Einstein. Par Dr. Leon Bloch. (Bibliothèque des Annales des Postes, Télégraphes et Téléphones.) Pp. iii + 42. (Paris: Gauthier-Villars et Cie, 1922.) 3.50 francs.

The Romanes Lecture, 1922. *The Theory of Relativity and its Influence on Scientific Thought.* Delivered in the Sheldonian Theatre, May 24, 1922. By Prof. A. S. Eddington. Pp. 32. (Oxford: Clarendon Press, 1922.) 2*s.* net.

ANOTHER collection of books and pamphlets reminds us of the hold which the theory of relativity has on the public imagination.

The Abbé Moreux gives his book the title "Pour comprendre Einstein," though he seems to consider that the effort to understand him is so much waste of time, for in his view the theory is both superfluous and misleading. Dr. Strasser, an anatomist with an amateur's interest in physics, gives us a critical discussion of the theory, but it is manifest that he has not come near to understanding it. Prof. Rougier, a philosopher who has read all about the new physics, sets out to tell us something of the influence of the theory upon philosophy, but leaves us with the impression of a shallow and ill-digested understanding of the development of physical science and tells us little about philosophy. Prof. du Pasquier and Dr. L. Bloch are less ambitious in their aims; they are content to be expositors and not critics. The results are correspondingly more successful and will probably be very useful to the French reader.

But among the books before us, the English reader naturally turns to Prof. Eddington's Romanes Lecture to hear the latest thoughts of one who has done more than any man living to establish and to popularise the general theory of relativity.

The lecturer impresses it upon his audience that it is stale news that the events around us form a world of four dimensions. There is, however, something that is new. It used to be customary for us to think of this four-dimensional world as having a definite set of sections, any one of which represented the state of the universe at a particular moment of absolute time, the whole being thus stratified in recognisable layers. But now this stratification has disappeared, there are no absolute time sections; it is only the individual observer who, to meet his own convenience, dissects the whole into "rashers," labelling each with the mark of an instant of his own consciousness. With a wealth of illustration and with language both grave and gay Prof. Eddington seeks to cure us of our egoistic outlook, and to persuade us to the wider view which finds truth, not in a particular picture of reality seen from one angle, but in a vision which includes and comprehends every possible picture. "It is only in this undissected combination of four dimensions that the experiences of all observers meet." On this we need scarcely dwell here, save to remind ourselves that the fault from which he would save us is one to which men in all ages have been prone, and not the least sinners have been those whose profession was the pursuit of exact truth. Yet we cannot help feeling that at times the preacher goes too far and so damages his case. To quote an illustration from the lecture. We allow an apple to fall. The moment the apple is released the earth begins to rush up to meet it. This is "the apple's view of things." "It is simpler than Newton's. We should regard it as on an equal footing with that of a terrestrial observer." This is very like asking an engine-driver to admit that it is quite natural to consider that when he admits the steam to the cylinder he sets not the engine but the whole universe in motion.

This is trifling however. Let us return to our destratified world of four dimensions. If we have been able to achieve this vision or to conceive of its possibility, we have grasped the essence of the doctrine of relativity, and we have come near to a superhuman view of history. The world is laid out before us as a changeless whole. Time and space are no more.